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Assessment Tool of Course Learning Outcomes for Mechanical Design of Process Equipment

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Abstract

Elements of learning outcomes (CO) are one of the factors that affect in the context of results-based learning (OBE) or Outcome Based Education (OBE). Based on accreditation by the Engineering Accreditation Council (EAC) at the Department of Chemical and Process Engineering for the year 2010, the need for learning outcomes assessment, CO for both programs, Chemical Engineering and Biochemical Engineering, should be implemented in order to make the relationship between Program Outcomes (PO) and CO. Learning outcomes assessment for the course of KKKR3654 Mechanical Design of Process Equipment Year III at Department of Chemical and Process Engineering (JKKP), UKM was conducted with lecturers giving questionnaires to students at the beginning of the lecture week (first week to the fifth) and in the last week learning (weeks 10 to 14) in order to compare student understanding of the course. Methods used involved a sample of 58 students for both programs, and also direct and indirect measurement. Direct measurement was done by linking the statement for each CO to questions on quizzes, mid-semester exams, final examination and Integrated Projects. Results from the questionnaires were analyzed by the Likert method and converted into percentage marks. In general the percentage of CO for both programs at the end of the semester increased between 76-83% compared with that of the beginning of semester.

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Keywords: Program outcomes; course utcomes; direct measurement; indirect measurement; Mechanical Design of Process Equipment

1. Introduction

Learning outcomes are defined as expectations of what students should know and can do after the completion of their course of study [1]. Elements of learning outcomes assessment program (PO) and learning outcomes

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(CO) is a factor that affects the context of Outcome Based Education (OBE), which commenced in the Faculty of Engineering and the Built Environment since Semester I 2005 / 2006 [2-3]. Department of Chemical and Process Engineering (JKKP) has two programs namely Chemical Engineering (KK) and Biochemical Engineering (KB) has begun to implement measurement and evaluation of CO in Semester II Session 2011/2012 for the course KKKR1244 Chemical Engineering Thermodynamics II; KKKR3654 Mechanical Design of Process Equipment and KKKR3612 Chemical Engineering Laboratory IV.

PO measurement of both programs have been successfully implemented in a direct measurement (evaluation by lecturer) and indirect assessment (student questionnaires) through project-based courses such as Integrated Project, research project and laboratory [4-8]. CO measurement has not yet been assessed due to some problems. Based on accreditation by the Engineering Accreditation Council (EAC) at the Department for the year 2010, the need for assessment of learning outcomes, CO for the two programs, should be implemented in order to make the relationship between PO and CO.

Hence this paper outlines the procedure for evaluating and measuring CO for KKKR3654 Mechanical Design of Process Equipment for both programs, KK and KB in Semester II Session 2011/2012. The entire COs for KKKR3654 are listed in Table 1.

Table 1 CO statements for KKKR3654 Mechanical Design of Process Equipment

CO	Course Outcome Statement
CO1	Understanding of the basic theories in the mechanical design of pressure vessels
CO2	Ability to perform stress analysis on a shell membrane rotating general and apply to the rotating cylindrical shell, sphere, hemisphere, cone, ellipsoid, torus and torisfera
CO3	Ability to derive conclusions minimum thickness for a flat plate (clamped on the side and simply supported).
CO4	Knowledge of design factors that should be considered in the design of a pressure vessel: pressure and temperature design, selection of materials, design loads, corrosion truth.
CO5	The ability to determine the minimum thickness and maximum allowable working pressure (MAWP) of the pressure vessel (cylinder or sphere) and the lid of the container (hemisphere, torisfera, ellipsoidal and conical), whether that be internal or external pressure according to ASME code.
CO6	Ability to design a pressure vessel that is subjected to merge as dead weight loads, wind loads, seismic loads, and eccentric loads.
CO7	Ability to design a former supporter of the pressure applied load and flange former compound.
CO8	Ability to provide complete engineering drawings for pressure vessels

2. Methodology

Two methods of direct and indirect measurement were implemented to assess and evaluate the students' achievement on COs for KKKR3654 Mechanical Design of Process Equipment. The indirect measurement was through questionnaires distributed to students by lecturers in the beginning (Week 1 – Week 5) as well as at the final lecture week (Week 10 - Week 14). The distributed questionnaire was based on Likert Scale (Table 2) asking the students to give their level of understanding on each CO. The average score for each CO was converted into mark percentage and compared with CO measured through direct assessment. The direct measurement was performed by relating each question in examinations, project and quiz with the dedicated CO (Table 3). The overall marks obtained by each students from the assessment of quiz (10%), mid-semester examination (25%), final examination (40%) and Integrated Project (25%) was separated according to the CO

achievements. Then, the direct measurement of CO was compared to the CO achievements of students obtained through indirect measurement from the distributed questionnaire.

Table 2 Scale used in indirect measurement

Scale	Statement
0	No idea
1	Know specific facts, terms, concepts, principles or theories
2	Understand and able to interpret specific facts, terms, concepts, principles or theories
3	Able to apply related theories to new situation and able to solve related problems
4	Able to use the related knowledge and theories to design a chemical or biochemical engineering system
5	Able to use the related knowledge and theories to analyze and evaluate a chemical or biochemical engineering system

Table 3 Relationship of direct measurement with dedicated CO for KKKR3654

Assessment instruments	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8
Quiz	√	√			√	√		
Mid Sem. Exam	√		√	√				
Final Exam	√		√	√		√		
Integrated Project					√	√	√	√

3. Results and Discussion

The questionnaires were given to 58 students for both programs, and the feedback was 100%. The analysis results for each stated CO shows that, most of the students gave responses in the range of (15-31%) at the beginning of the semester and 83-88% at the end of semester to the level of understanding and abilities of each CO. This can be seen in Figures 1 and 2 for the respective Chemical and Biochemical Engineering Programs. Figure 1(a) clearly shows that most of the students gave an expected response from a scale of 0 to 3, especially in CO5, CO6 and CO7. These results imply that student cannot make an initial overview of the stated CO at the beginning of the semester.

Learning outcomes at the end of the semester for KK program shows that most students gave positive feedback, within a scale of 4 and 5, as shown in Figure 1(b), giving evidence that at the end of the semester most students had a better understanding and ability to achieve the outcomes of the course.

Figure 2 depicts the results of CO achievement of KKKR3654 course for Biochemical Engineering Program. From Figure 2(a), it clearly shows that at the beginning of each semester (6-34%), most of the feedback is more on a scale of 0, 1 and 2. Overall, there is a significant improvement on the students' understanding at the end of the semester (87-95%) as shown in Figure 2(b). From Figures 1 and 2, it obviously shows that most of the students have achieved specified learning outcomes at the end of the semester.

To ensure that the assessment carried out through questionnaire in the agreement with the requirements of CO, then the results from the direct measurement were compared with the direct ones for each CO statement. Figures 3 and 4 compare the results from the two measurements, direct and indirect ones. For both program KK and KB, almost similar results for each CO were obtained. These results indicate that the feedback provided by students at the end of the semester is in line with the marks obtained for each set of measurement instruments. Overall, the average score for the direct measurement of CO is 56-94% and 56-99% for KK for KB.

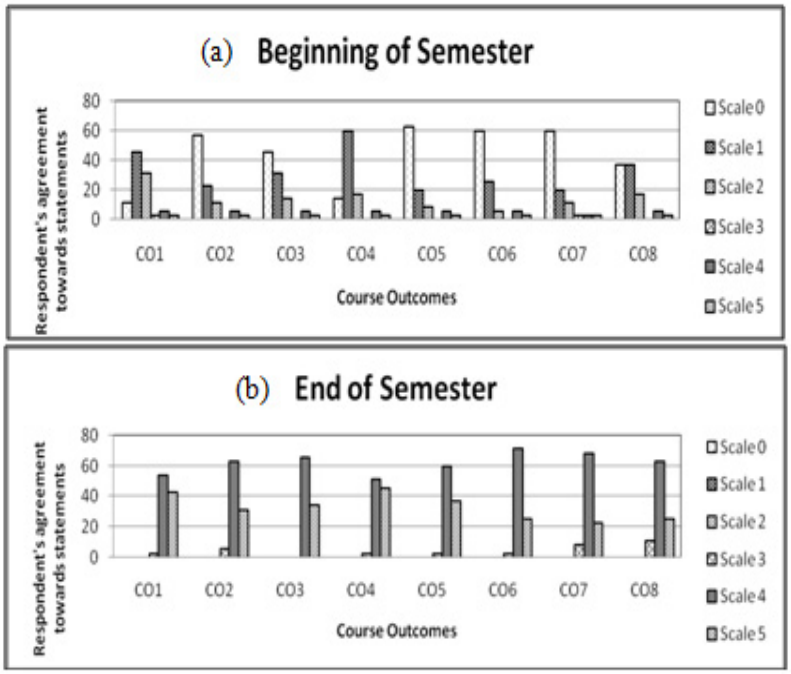

Fig. 1. Indirect measurement of CO at the beginning and at the end of the semester for KKKR3654 Mechanical Design of Process Equipment for Chemical Engineering Program

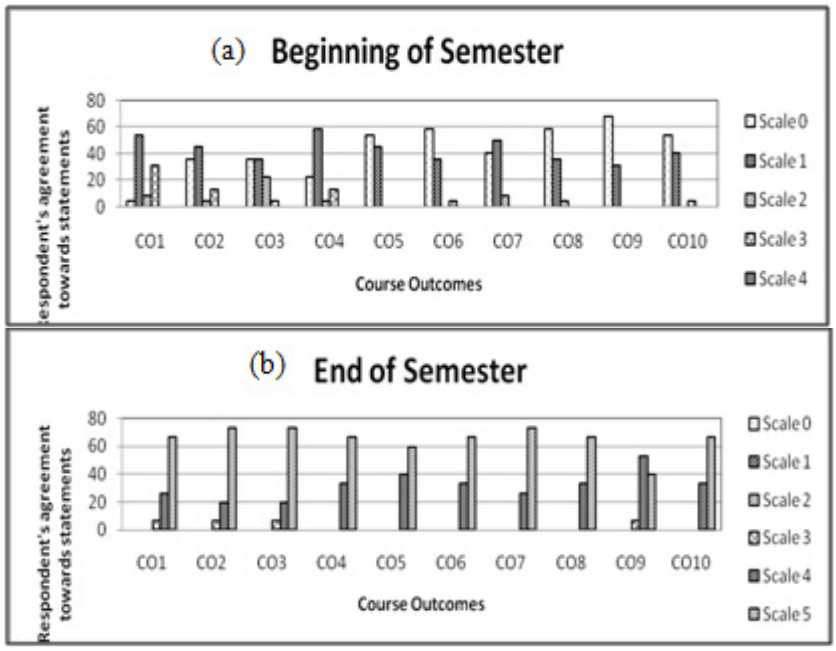

Fig. 2. Indirect measurement of CO at the beginning and at the end of the semester for KKKR3654 Mechanical Design of Process Equipment for Biochemical Engineering Program

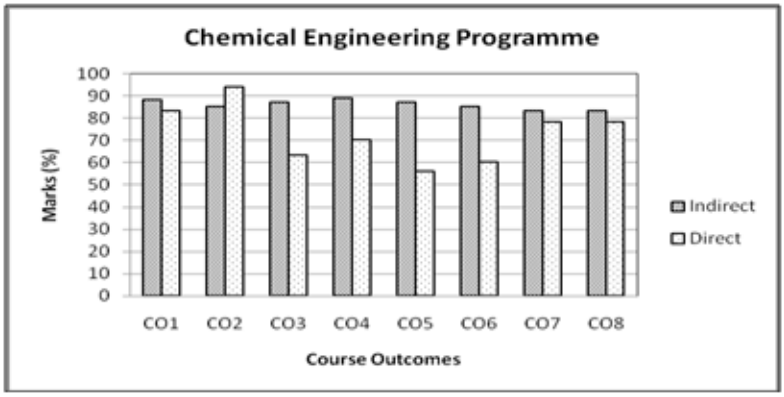

Fig. 3. Comparison of the course learning outcomes (CO) from direct and indirect measurement (KK)

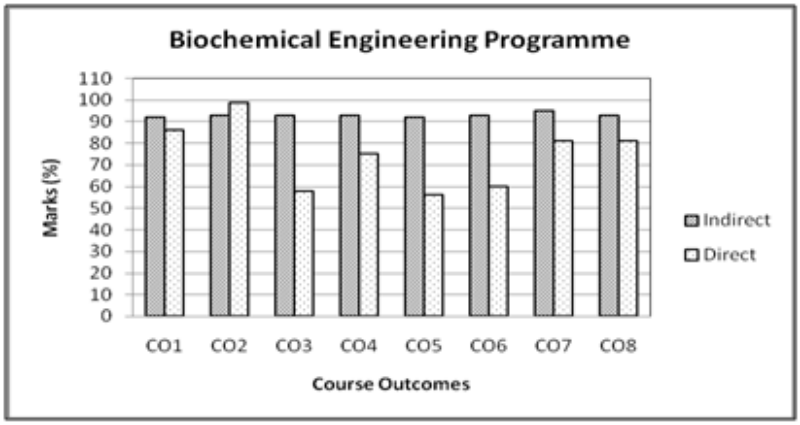

Fig. 4. Comparison of the course learning outcomes (CO) from direct and indirect measurement (KB)

3. Conclusions

Overall, the procedure carried out in the JKKP to assess and measure learning outcomes, CO, for KKKR3654 Mechanical Design of Process Equipment, as compulsory course for students in Year III, have been successfully implemented. Results show that the method of measurement and evaluation of CO at the beginning and end of the semester is closely related to the final grade obtained by the students for this course. In general the percentage of CO for this course at the end of the semester increased between 80-90% compared with the beginning of semester.

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